U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: GUIDELINES FOR USING GLOBAL POSITIONING SYSTEM EQUIPMENT FOR IFR EN ROUTE AND TERMINAL OPERATIONS AND FOR NONPRECISION INSTRUMENT APPROACHES IN THE U.S. NATIONAL AIRSPACE SYSTEM

Date: 12/14/94
Initiated By: AFS-800/400

AC No: 90- 94
Change:

1. PURPOSE. This advisory circular (AC) contains guidance for pilots to use Global Positioning System (GPS) equipment during instrument flight rules (IFR) navigation. It includes operating en route, in the terminal environment, during nonprecision instrument approach procedures in the U.S. National Airspace System (NAS), and in oceanic areas. Emphasis is placed on the GPS approach overlay program. This document is advisory only and not mandatory.

2. RELATED READING MATERIAL. The guidelines within this AC complement the following documents:

a. RTCA No. RTCA/DO-200, November 18, 1988, "Preparation, Verification and Distribution of User-Selectable Navigation Data Bases."

b. RTCA No. RTCA/DO-208, July 1991, "Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)."

c. Technical Standard Order (TSO) C129, December 10, 1992, "Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)."

d. FAA Advisory Circular 20-138, May 25, 1994, "Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for Use as a VFR and IFR Supplemental Navigation System."

e. FAA Order 8260.38, December 14, 1993, "Civil Utilization of Global Positioning System."

3. BACKGROUND. The Department of Defense (DOD) originally developed and deployed GPS as a space-based positioning, velocity, and time system for the military. The DOD is responsible for operating the GPS satellite constellation and constantly monitors the satellites to ensure proper operation. The GPS system permits earth-centered coordinates to be determined and provides aircraft position referenced to the DOD World Geodetic System of 1984 (WGS-84). Navigational values, such as

distance and bearing to a waypoint and ground speed, are computed from the aircraft's current position (latitude and longitude) and the location of the next waypoint. Course guidance is provided as a linear deviation from the desired track of a Great Circle route between defined waypoints.

(1) The rapid development of this technology and the establishment of Technical Standard Order (TSO) C129, "Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)", has made possible the first civil aviation use of GPS in IFR procedures.

(2) TSO C 129 sets the minimum performance standards that GPS airborne supplemental area navigation equipment must meet to operate in the U.S. NAS during en route, terminal, and nonprecision approach procedures. ***Note:*** *equipment approved to TSO C115a does not meet the requirements of TSO C129.*

(3) The Department of Defense (DOD) declared initial operational capability (IOC) of the U.S. GPS on December 8, 1993. The FAA then issued a notice to airmen (NOTAM) on February 17, 1994, declaring GPS operational for certain civil IFR applications. A NOTAM, issued March 3, 1994, specified the applications.

4. DEFINITIONS. Since this AC contains several technical terms which may not be familiar to the new GPS user, a list of definitions can be found in the Glossary, Appendix 2.

5. COMMENTS INVITED. Comments regarding this publication should be directed to the following address:

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Comments may not require a direct acknowledgment to the commentor; however, they will be considered in the development of upcoming revisions to AC's or other related technical material.

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SECTION 1. GENERAL.

1. BACKGROUND. Satellite navigation systems provide global navigation that fully meets the civil aviation requirements for use as the primary means of navigation. Developments in satellite technology and its use for aircraft navigation are such that it may be expected that several satellite navigation systems will evolve in the future, each with its own unique characteristics. The International Civil Aviation Organization (ICAO) has adopted "Global Navigation Satellite System (GNSS)" as an umbrella term to identify any satellite navigation system where the user performs onboard position determination from satellite information. When this Advisory Circular (AC) was written, only two systems had filed with the International Frequency Registration Board (IFRB): the Global Positioning System (GPS) developed by the United States and the Global Orbiting Navigation Satellite System (GLONASS) now under development by the Federation of Russia. This AC provides guidance for the use of satellite navigation in the U.S. National Airspace System (NAS) and oceanic navigation. The terminology and guidelines are limited to the U.S. developed GPS technology. This document does not address the use of other GNSS systems in the U.S. NAS, nor the use of GPS in other civil aviation authority airspace.

2. SYSTEM DESCRIPTION. GPS consists of three distinct functional elements: space, control, and user. GPS utilizes range measurements from the satellites to determine a position anywhere in the world.

a. The space element consists of 24 Navstar satellites. This group of satellites is called a constellation. The satellites are in six orbital planes (with four in each plane) at about 11,000 miles above the earth. At least four satellites are in view at all times. The GPS constellation broadcasts a pseudo-random code timing signal and data message that the airborne equipment processes to obtain satellite position and status data. By knowing the precise location of each satellite and precisely matching timing with the atomic clocks on the satellites, the airborne receiver can accurately measure the time each signal takes to arrive at the receiver and, therefore, determine aircraft position.

b. The control element consists of a network of GPS monitoring and control stations that ensure the accuracy of satellite positions and their clocks. In its present form, it has five monitoring stations, three ground antennas, and a master control station.

c. The user element consists of antennas and receiver-processors onboard the aircraft that provide positioning, velocity, and precise timing to the user.

d. A minimum of three satellites must be in view to determine lateral guidance (2D position). Four satellites must be in view to provide both lateral and vertical guidance (3D position).

3. GPS IN THE NATIONAL AIRSPACE SYSTEM (NAS)

a. General. GPS Instrument Flight Rules (IFR) operations for en route (oceanic and domestic), terminal, and nonprecision approach phases of flight can be conducted when GPS avionics approved for IFR are installed in the aircraft. This equipment should be installed in accordance with AC 20-138 and the provisions of the applicable Approved Flight Manual (AFM) or Flight Manual supplement should be met. The required integrity for these operations is provided by Receiver Autonomous Integrity Monitoring (RAIM), or an equivalent method. For air carrier operations, operations specification approval is required to use GPS.

b. Oceanic En Route. Aircraft using GPS equipment under IFR must be equipped with an approved and operational alternate means of navigation (such as VOR, NDB, or an approved long range navigation system such as LORAN or OMEGA) appropriate for the intended route to be flown. Active monitoring (cross checking) of the alternate equipment is not necessary for installations which use RAIM for integrity monitoring. For these systems, active monitoring by the flightcrew is only required when the RAIM capability is lost.

Note: Outside of the National Airspace System (NAS), GPS may be used as a Long Range Navigation System (LRNS). On those routes requiring two long range navigation systems, a GPS installation with TSO C-129 authorization in Class A1, A2, B1, B2, C1, or C2 may be used to replace or supplement one of the other approved means of LRNS's, such as one unit of a dual INS or one unit of a dual Omega system. On those routes requiring a single LRNS, a GPS unit which provides for integrity monitoring may be used as the LRNS and active monitoring of the alternate equipment is only required when the RAIM capability is lost. GPS may not be approved in other countries. Pilots should ensure that GPS is authorized by the appropriate sovereign state prior to its use within that state.

c. Domestic En Route. The aircraft must also have navigational equipment installed and operational that can receive the ground-based facilities required for the route to the destination airport and any required alternate. The ground-based facilities necessary for these routes must also be operational. These ground-based systems do not have to be actively used to monitor the GPS avionics unless RAIM failure occurs. Within the contiguous United States, Alaska, Hawaii, and surrounding coastal waters, this requirement may be met with an operational independent VOR, NDB, TACAN, or LORAN-C receiver in addition to the GPS system for IFR operation.

***Note:** GPS may not be approved for IFR use in other countries. Pilots should ensure that GPS is authorized by the appropriate sovereign state prior to its use.*

d. Terminal. GPS IFR operations for the terminal phases of flight, Standard Instrument Departures (SIDs), and Standard Terminal Arrival Routes (STARs) should be conducted the same as existing RNAV procedures dictate. The aircraft also must have navigational equipment installed and operational that can receive all the ground-based facilities appropriate to the route of flight. The ground-based facilities necessary for these routes must also be operational; however, they do not have to be actively used to monitor the GPS avionics unless the RAIM fails.

e. Approach Overlay Program. To accelerate the availability of instrument approach procedures to be flown using certified GPS equipment, the FAA developed the GPS Approach Overlay Program. This program allows pilots to use GPS equipment to fly existing VOR, VOR/DME, NDB, NDB/DME, TACAN, and RNAV nonprecision instrument approach procedures. The approach overlay program is limited to U.S. airspace. GPS instrument approach operations outside the U.S. must be authorized by the appropriate sovereign state. The purpose of the approach overlay program is to permit pilots to transition from ground-based to satellite-based navigation technology for instrument approaches. GPS equipment may be used to fly all nonprecision instrument approach procedures that are retrieved from a database, except localizer, localizer directional aid (LDA), and simplified directional facility (SDF) approach procedures. Any required alternate airport must have an approved instrument approach procedure, other than GPS or LORAN-C, which is anticipated to be operational at the estimated time of arrival. The approach overlay program consists of three phases. Each phase has specific provisions and limitations as presented below.

(1) Phase I. This phase ended in February 1994, the date when the FAA declared GPS operational for civil operations.

(2) Phase II. This phase began on February 17, 1994 when the FAA declared the system suitable for civil operations. Certified GPS equipment can be used as the primary IFR flight guidance to fly an overlay to an existing nonprecision approach without actively monitoring the applicable navaid(s) which define the approach being used. However, the underlying ground-based navaid(s) required for the published approach must be operational and the associated avionics must be installed and operational. The avionics need not be operating during the approach if RAIM is providing integrity. Pilots can tell that Phase II applies because "GPS" is not included in the title of the approach.

(3) Phase III. Phase III began April 28, 1994, when the first instrument approach procedures were published to include "or GPS" in the title of the published approach procedure. Neither the aircraft traditional avionics nor the underlying ground station navaid(s) need be installed, operational, or monitored to fly the nonprecision approaches at the destination airport. For GPS systems that do not use RAIM for integrity, the ground-based navaid(s) and the airborne avionics that provide the equivalent integrity must be installed and operating during the approach. For any required alternate airport, the traditional ground-based and airborne navigational equipment that defines the instrument approach procedure and route to the alternate must be installed and operational.

f. GPS Stand Alone Approaches. Stand alone nonprecision approaches, which are not overlaid on an existing approach, are the next step beyond the overlay program. The first stand alone GPS approaches were published on July 21, 1994. The airborne and ground-based navaid requirements are the same for GPS stand alone approaches as for Phase III overlay approaches.

g. Overlay and Stand Alone Approaches. There will continue to be a mixture of nonprecision Phase II, Phase III, and GPS stand alone approaches in the U.S. NAS for some time. Most nonprecision instrument approach procedures in the U.S. (except localizer, LDA, and SDF) are available under Phase II of the overlay program. Eventually, these approaches may become Phase III approaches as they change to include "or GPS" in their titles. Additionally, the FAA will continue to develop and authorize stand alone GPS approaches.

4. GPS EQUIPMENT CLASSES A(), B(), AND C(). GPS equipment is categorized into the following classes:

a. Class A(). Equipment incorporating both the GPS sensor and navigating capability. This equipment incorporates Receiver Autonomous Integrity Monitoring (RAIM). Class A1 equipment includes en route, terminal, and nonprecision approach (except localizer, localizer directional aid (LDA), and simplified directional facility (SDF)) navigation capability. Class A2 equipment includes en route and terminal navigation capability only.

b. Class B(). Equipment consisting of a GPS sensor that provides data to an integrated navigation system (i.e. flight management system, multi-sensor navigation system, etc.). Class B1 equipment includes RAIM and provides en route, terminal, and non-precision approach (except localizer, LDA, and SDF) capability. Class B2 equipment includes RAIM and provides en route and terminal capability only. Class B3 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route, terminal, and non-precision approach (except localizer, LDA, and SDF) capability. Class B4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route and terminal capability only

c. Class C(). Equipment consisting of a GPS sensor that provides data to an integrated navigation system (i.e., flight management system, multi-sensor navigation system, etc.) which provides enhanced guidance to an autopilot or flight director in order to reduce flight technical errors Class C1 equipment includes RAIM and provides en route, terminal, and nonprecision approach (except localizer, LDA, and SDF) capability. Class C2 equipment includes RAIM and provides en route and terminal capability only. Class C3 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route, terminal, and nonprecision approach (except localizer, LDA, and SDF) capability. Class C4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route and terminal capability only.

GPS IFR EQUIPMENT CLASSES/CATEGORIES (TSO-C129)						
Equipment Class	RAIM	Integrated Navigation System to Provide RAIM Equivalent	Oceanic	En Route	Terminal	Non-Precision Approach Capable
Class A — GPS sensor and navigation capability.						
A1	yes		yes	yes	yes	yes
A2	yes		yes	yes	Yes	no
Class B — GPS sensor data to an integrated navigation system (i.e. FMS, multi-sensor navigation system,etc.)						
B1	yes		yes	yes	yes	yes
B2	yes		yes	yes	yes	no
B3		yes	yes	yes	yes	yes
B4		yes	yes	yes	yes	no
Class C — GPS sensor data to an integrated nav. system (as in Class B) which provide enhanced guidance to an autopilot, or flight director, to reduce flight technical errors enhanced guidance to an autopilot, or flight director, to reduce flight technical errors						
C1	yes		yes	yes	yes	yes
C2	yes		yes	yes	yes	no
C3		yes	yes	yes	yes	yes
C4		yes	yes	yes	yes	no

Figure 1. GPS Equipment Classes

5. GPS SYSTEM ACCURACY/ERRORS. GPS equipment determines its position by precise measurement of the distance from selected satellites in the system, and the satellites' known location. Accuracy measurements are affected by satellite geometry which multiplies the effect of other errors in the system, slight inaccuracies in the satellite clocks, receiver processing, signal reflections, and predictions of current satellite position that are transmitted to the receiver in the satellite data message.

a. Selective Availability (SA). A method by which the DOD can artificially create errors in the signals from the satellites. This feature is designed to deny a potential enemy the use of precise GPS positioning data. This is the largest source of error in the GPS system. When SA is active, the DOD guarantees that the horizontal position accuracy will not be degraded beyond 100 meters (328 feet) 95 percent of the time and 300 meters (984 feet) 99.99 percent of the time.

b. Reducing Errors. The accuracy of GPS position data can be affected by equipment and the satellite geometry being received. Many of these errors can be reduced or eliminated with mathematics and sophisticated modeling provided by the airborne receiver. Other sources of error cannot be corrected.

SECTION 2. AIRBORNE NAVIGATION DATABASES.

1. REQUIREMENT FOR A DATABASE. To conduct IFR operations using GPS equipment to navigate in the U.S. NAS and oceanic airspace, the aircraft GPS equipment must include an updatable navigation database. That database will support en route and terminal operations; or en route, terminal, and nonprecision instrument approach (except localizer, LDA, and SDF) operations.

a. Geographic Area of Content. Airborne navigation databases contain data covering the geographic areas where GPS navigation systems have been certified for IFR use. Data may cover large geographic areas or small user-defined areas within the U.S. NAS and related oceanic areas.

b. Database Description. GPS airborne navigation databases are provided initially by the receiver manufacturer and updated by the manufacturer or a designated data agency. The databases contain records of location information by latitude and longitude to a resolution of 0.01 minutes or better for the area(s) in which IFR operations are approved. The database is user selectable which allows the pilot to make specific selections during flight operations to support navigational needs. The database may also be user defined in that the information is tailored to the requirements of a user.

Note: *Manual entry/update of data in the navigation database shall not be possible. (This requirement does not prevent the storage of "user-defined data" within the equipment.)*

c. Update of Data. Waypoint information is provided and maintained by the National Flight Data Center (NFDC). The data is typically updated at regular intervals such as the internationally agreed upon Aeronautical Information Regulation and Control (AIRAC) cycle of every 28 days.

d. Geodetic Reference Datum. The GPS equipment derives position information referenced to the World Geodetic System of 1984 (WGS-84). Databases produced for use in the contiguous United States, Alaska, and Hawaii contain coordinates of location information referenced to the North American Datum of 1983 (NAD 83). For this Advisory Circular, coordinates of locations referenced to NAD 83 are compatible with the coordinates of the same locations referenced to WGS-84.

2. EN ROUTE (OCEANIC AND DOMESTIC) AND TERMINAL NAVIGATION. Navigation databases supporting GPS equipment certified for en route (including en route oceanic and en route domestic) and terminal operations contain, as a minimum, all airports, VORs, VORTACs, NDBs, and all named waypoints and intersections shown on en route and terminal area charts, SIDs, and STARs. The databases incorporate information from the geographic areas of the contiguous United States, Alaska, Hawaii, and surrounding coastal waters including waypoints and intersections for oceanic flight between the United States and Hawaii. For oceanic flights outside the NAS, user selectable data is available for most GPS receivers.

a. In the terminal area, the database will include waypoints for SIDs and STARs as well as other flight operations from the beginning of a departure to the en route structure or from an en route fix to the beginning of an approach procedure.

b. All named waypoints are identified with a five-letter alpha character name provided by the NFDC. Waypoints unnamed by the NFDC, such as a DME fix, are assigned a coded name in the database (refer to the sample approach plates in Appendix 1)..

c. Waypoint latitude and longitude coordinates are typically displayed in degrees, minutes, and tenths of minutes or hundredths of minutes. However, this may vary between equipment manufacturers.

3. INSTRUMENT APPROACH PROCEDURE NAVIGATION. In addition to the data which supports en route and terminal operations, a navigation database that supports GPS overlay nonprecision instrument approaches (except localizer, LDA, and SDF) contains coordinates for the waypoints, fixes, and navaids published in FAR Part 97, Standard Instrument Approach Procedures. Special instrument approach procedure data may be included at the request of those operators authorized to use the procedures. Data for approach procedures into military airports also may be included if the procedures are available, and authorized for civil operations. In addition, all waypoints to support GPS stand alone approaches are also contained in the database.

4. THE GPS APPROACH OVERLAY PROGRAM. The navigation database coding should not change during any phase of the GPS Approach Overlay Program, except for modifications necessary to support changing rules and/or technology. Approaches coded into the database are limited to U. S. airspace. Approaches for other airspace will not be included until authorized by the FAA as well as the appropriate sovereign authority. Whether or not an approach is included in the database depends on its codability and flyability using GPS equipment. Therefore, FAR Part 97, military, and special approaches are classified into codable and non-codable nonprecision instrument approaches.

Note: *An aircraft is not authorized to fly any IFR approach using GPS unless that instrument approach procedure is retrievable from the navigation database.*

a. Codable Approach Procedures. The navigation database contains latitude and longitude coordinates for waypoints, fixes, and navaids for those FAR Part 97 civil use, and military, nonprecision approaches considered codable for database purposes and considered safe to fly by the FAA using normal piloting techniques. Special approaches may be included at authorized user request.

b. Non-Codable Approach Procedures. Certain FAR Part 97 nonprecision instrument approaches as well as some military and special procedures may present an unresolvable coding situation relating to database or equipment interface constraints. An approach may be determined to be not codable or not flyable by the regulatory agency having jurisdiction (FAA), by the database coding agency, or by the manufacturer of the navigation equipment. In addition, some procedures may, in the opinion of the FAA, present a potential safety hazard to normal piloting techniques using GPS equipment. These procedures will not be included in navigation databases. Approach procedures that are omitted from the database can not be legally flown using GPS navigation equipment.

c. Waypoints. As a minimum, the GPS Approach Overlay Program requires that the databases contain waypoints representing the IAF, FAF, MAP, and the missed approach holding point for each VOR, VOR/DME, NDB, NDB/DME, TACAN, and RNAV nonprecision instrument approach procedure. Intermediate Fixes (IFs) and all named fixes are also included. All waypoints are displayed in the same sequence as they are presented on the published nonprecision instrument approach procedure charts.

Note: *User modification or entry of data associated with published instrument approach procedures is not possible, and not authorized.*

(1) Waypoint data utilized in nonprecision instrument approach procedures is stored by name or ident, and latitude and longitude. The waypoints are not designated in terms of bearing (or radial) and distance to/from a reference location.

(2) Waypoints that define the MAP and Missed Approach Holding Point (MAHWP) are always coded as "fly over." This type of waypoint requires the aircraft to pass directly over it.

(3) When turn anticipation is expected at an IAF or other waypoint the waypoint is coded as "fly by."

d. Waypoint Names Coded in the Navigation Database. Flying an FAR Part 97 or military nonprecision instrument approach procedure using GPS equipment should be transparent to air traffic control. Therefore, if a pilot has a clearance for the VOR/DME to runway 35, the same track is flown whether using GPS equipment or VOR and DME equipment. Therefore, waypoints coded in the navigation database reflect exactly those names appearing on the instrument approach procedure. For example, if an IAF or other fix is assigned a pronounceable five-letter alpha character name, it will be the same name coded in the database, the name which will appear on the avionics display, the name appearing on a chart, and the name verbally used by ATC. If no five character name is published for the approach waypoint or fix, it will normally be coded with a database identifier. A pilot must associate the coded name appearing on the display with the position shown on the chart. However, these coded names may not be known or used by ATC.

(1) Initial Approach Waypoint.

(i) If the IAF is a named waypoint or fix, then the same name is used for the IAF waypoint in the database. If the IAF is a navaid, the IAF waypoint is coded with the navaid identifier.

(ii) A database identifier is provided for an unnamed IAF.

(iii) When an IAF is the beginning of a DME arc segment, the IAF is often unnamed, but is marked by a radial intersecting the arc. In these cases, the unnamed IAF waypoint is coded in the database to represent the beginning of the DME arc. An example of one method of identifying the beginning of the arc is shown in the Lake Charles, LA chart example in Appendix 1.

(2) Turnings points in the Initial Segment. An initial segment may incorporate a named or unnamed turn point to intercept a course.

(i) In some cases, a waypoint may be established at a turn point where a dead reckoning heading intersects the course. This waypoint is coded into the waypoint sequence for GPS navigation, but may not be named on a chart.

(ii) A turn point may be defined by the intersection of two navaid radials or bearings. In this case, a waypoint name appears in the sequence.

(3) Intermediate Waypoint. If the IF is a named waypoint or fix, then the same name is used for the IF waypoint in the database. If the IF is a navaid, the IF waypoint is coded with the navaid identifier. An unnamed IF is assigned a database identifier.

(4) Final Approach Waypoint.

(i) Procedures With a Final Approach Fix (FAF). If the FAF is a named waypoint or fix, the same name is used for the FAF waypoint in the database sequence. If the FAF is a navaid, the waypoint is coded with the navaid identifier in the waypoint sequence. An unnamed FAF, such as a DME fix, is coded with a descriptive FAF waypoint related to the navaid providing final approach course guidance. It also appears in the waypoint sequence.

(ii) Procedures Without a Final Approach Fix. Procedures without a FAF and without a stepdown fix have a Sensor FAF waypoint coded in the database at least 4nm to the MAP waypoint. (The MAP, in this case, is always located at the navaid facility.) A Sensor FAF is a final approach waypoint created and added to the database sequence of waypoints to support GPS navigation of an FAA published, no-FAF, nonprecision instrument approach procedure. The coded name or Sensor FAF appears in the waypoint sequence. If a stepdown fix exists on the published procedure and it is greater than 2nm to the MAP, the stepdown fix is coded in the database as the Sensor FAF waypoint for the waypoint sequence. If a stepdown fix distance is 2nm or less to the MAP, a Sensor FAF waypoint is coded at least 4nm to the MAP.

(5) Missed Approach Waypoint. When a missed approach point is located at the navaid, the MAP waypoint is coded in the sequence at the navaid position using the navaid identifier. When the missed approach is initiated near the runway threshold (timed approach) or at a specified DME distance from a navaid, a MAP waypoint is created and coded in the database (see approach plates in Appendix 1).

(6) Missed Approach Holding Points. Missed approach holding points are normally at a navaid or named fix. Therefore, the navaid identifier or the fix name is coded in the database as the missed approach holding waypoint and appears in the waypoint sequence.

(7) Waypoints and Fixes not Coded for the GPS Approach Overlay Program. A Visual Descent Point (VDP) is a fix appearing on some published nonprecision approach procedures that is not included in the sequence of waypoints. Pilots are expected to use normal piloting techniques for beginning the visual descent. In addition, unnamed stepdown fixes in the final approach segment will not be coded in the waypoint sequence unless the stepdown fix is used as a Sensor FAF on a no-FAF procedure.

e. Approach Selection Process/Menu Sluing. Pilots normally retrieve instrument approach procedures from the database through a menu selection process. An example of a menu selection is included in the Pilot Operations/Procedures section of this AC. No manual waypoint loading will be required or allowed, although some pilot action is required during certain segments of the approach.

Note: *This process may vary from one avionics manufacturer to another; therefore, pilots must be thoroughly familiar with the FAA Approved Flight Manual or Flight Manual supplement.*

f. Waypoint Sequence. The sequence of waypoints in the database and those displayed by the equipment will consist of, as a minimum, waypoints representing the selected IAF and its associated IFs (when applicable), FAF, MAP, and the MAHWP.

g. Relationship of Avionics Displayed Waypoints to Charted Data. The GPS Approach Overlay Program waypoints contained in the database represent the waypoints, fixes, navaids, and other points portrayed on a published approach procedure beginning at the initial approach fix. Certain unnamed points and fixes appearing on a chart are assigned a database identifier. There is no requirement to furnish charts with these database identifiers; however, charting agencies may incorporate them at their discretion.

Note: *Database identifiers should not be used for pilot/controller communications and flight planning.*

h. Differences Between Displayed and Charted Navigation Information. There may be slight differences between the navigation information portrayed on the chart and the GPS navigation display. Course differences will occur due to an equipment manufacturer's application of magnetic variation. Distance differences will occur due to the mismatch between GPS ATD values and the DME values published on underlying procedures.

5. THE GPS STAND ALONE APPROACH. A sequence of waypoints defining the point to point track to be flown will be coded in the database including the initial approach waypoint, intermediate waypoint, final approach waypoint, missed approach waypoint, missed approach turning waypoint, and missed approach holding waypoint. All waypoints, except a missed approach waypoint at the runway threshold, will be named with a five-letter alpha character name. Missed approach waypoints at the threshold will be assigned a database identifier. The sequence of waypoints appearing in the display should be identical to the waypoint sequence appearing on an associated approach chart.

SECTION 3. PILOT OPERATIONS/PROCEDURES.

1. APPLICABILITY.

a. The guidance provided in this AC applies to instrument rated pilots using GPS and operating under Federal Aviation Regulations (FAR) Part 91.

b. Pilots conducting GPS IFR operations under FAR Parts 121, 129, and 135 should meet the appropriate provisions of their approved operations specifications.

2. PREFLIGHT.

a. General. All GPS IFR operations should be conducted in accordance with the FAA Approved Flight Manual (AFM) or Flight Manual Supplement. Prior to an IFR flight using GPS, the pilot should ensure that the GPS equipment and the installation are approved and certified for the intended IFR operation. The equipment should be operated in accordance with the provisions of the applicable AFM. All pilots must be thoroughly familiar with the GPS equipment installed in the aircraft and its limitations.

b. GPS Receivers. The pilot should follow the specific start-up and self-test procedures for the GPS receiver as outlined in the FAA AFM or Flight Manual Supplement.

c. NOTAMs. Prior to any GPS IFR operation, the pilot should review the appropriate NOTAMs. NOTAMs will be issued to announce outages for specific GPS satellite vehicles, by pseudo random noise (PRN) number and satellite vehicle number (SVN). GPS NOTAMs are issued under the identifier "GPS". Pilots may obtain GPS NOTAM information by request to the FSS briefer or by requesting NOTAMs, using the identifier "GPS", through the Direct User Access Terminal System (DUATS). Pilots should review the NOTAMs for the underlying approach procedure. When executing a Phase II approach, pilots should ensure the ground-based facilities upon which the approach is based are operational. If an approach is not authorized due to an inoperative navigation facility, the associated Phase II GPS approach is not authorized.

d. The pilot must select the appropriate airport(s), runway/approach procedure, and initial approach fix on the aircraft's GPS receiver to determine RAIM integrity for that approach. Air Traffic Control specialists are not provided any information about the operational integrity of the system. This is especially important when the pilot has been "Cleared for the Approach." Procedures should be established by the pilot in the event that GPS navigation outages are predicted or occur. In these situations, the pilot should rely on other approved equipment, delay departure, or cancel the flight.

e. Aircraft that are navigating by GPS are considered to be RNAV-equipped aircraft and the appropriate equipment suffix should be included in the Air Traffic Control (ATC) flight plan. Most GPS equipment would file as a /R. Users should consult the latest edition of the Airmen's Information Manual (AIM) for the proper equipment suffix. If the GPS avionics becomes inoperative, the pilot should advise ATC and amend the equipment suffix.

3. EN ROUTE OCEANIC. Oceanic operation is defined as that phase of flight between the departure and arrival terminal phases with an extended flight path over oceanic areas. In addition to the

criteria outlined in paragraph 3.b.(1), the aircraft should be equipped with other approved means of navigation appropriate for the intended route of flight, such as INS or Omega. This navigation equipment must be operational, but it does not have to be actively monitored unless the RAIM capability of the system fails. The purpose of the backup system is to ensure that the flight has the capability to continue to the destination if something unforeseen occurs to the GPS constellation.

4. EN ROUTE DOMESTIC AND TERMINAL. Domestic en route operations are defined as that phase of flight between departure and arrival terminal phases, with departure and arrival points within the U.S. NAS. Terminal area operations include those flight phases conducted on charted Standard Instrument Departures (SIDs), on Standard Terminal Arrival Routes (STARs), or during other flight operations between the last en route fix/waypoint and an initial approach fix/waypoint. In addition to the criteria outlined in paragraph 3.b.(1), the following criteria applies:

a. Other navigation equipment should be installed and operational to receive the intended ground-based facilities which define the route to be flown to the destination and any required alternate.

b. Ground-based facilities which define these routes must also be operational.

c. Aircraft should be equipped with an approved and operational alternate means of navigation appropriate to the route being flown. This navigation equipment must be operational, but it does not have to be actively monitored unless the RAIM capability of the system fails. The purpose of these backup systems is to ensure that the aircraft can continue to the destination if something unforeseen occurs to the avionics or GPS constellation.

5. OVERLAY APPROACH. In order to accelerate the availability of nonprecision instrument approach procedures that can be flown using certified GPS equipment, the FAA has authorized the GPS Approach Overlay Program. This program allows pilots to use GPS equipment to fly existing VOR, VOR/DME, NDB, NDB/DME, and RNAV nonprecision instrument approach procedures. The purpose of this program is to permit pilots to transition from ground-based to satellite-based navigation technology for instrument approaches. Approach operations are defined as that phase of flight from the Initial Approach Fix (IAF) to the Missed Approach Point (MAP) when flying an established nonprecision procedure. The approaches to be flown with GPS must be retrieved from the avionics database. (Refer to Section 2, "Airborne Navigation Databases" for a more detailed description of the required database.) GPS equipment may be used to fly all codable nonprecision instrument approach procedures, except localizer (LOC), localizer directional aid (LDA), and simplified directional facility (SDF) approach procedures. Any required alternate airport should have an approved instrument approach procedure (other than GPS or LORAN-C) which is anticipated to be operational at the estimated time of arrival. The program has progressed through three phases. Each phase has specific provisions and limitations.

a. Phase I. This phase ended in February 1994 when the FAA declared GPS operational for civil operations.

b. Phase II. This phase began on February 17, 1994 when the FAA declared the system suitable for civil IFR operations. GPS equipment can be used as the primary IFR flight guidance during a nonprecision approach without actively monitoring the applicable navaid(s) which define the approach being used. However, the traditional ground-based navaid(s) required for the published approach and alternate should be operational and the associated avionics should be installed and operational. The avionics need not be operating during the approach if RAIM provides integrity for the approach.

Equipment that does not use RAIM for approach integrity are required to use ground-based navaids and operational airborne avionics. The approach should be requested and approved by its published name, such as "NDB Runway 24," "VOR Runway 24." Modification of the published instrument approach name is not required for Phase II.

c. Phase III (After Name Modification). Phase III requires modification of the instrument approach procedure name to include "or GPS" in the title of the published approach procedure. Neither the aircraft traditional avionics nor the ground station navaid(s) need be operational or monitored to fly nonprecision approaches at the destination airport if RAIM is providing integrity for the approach. For systems that do not use RAIM for approach integrity the ground-based navaids and operational airborne avionics needed to provide RAIM equivalency should be installed and operational. For any required alternate airport, the ground-based and airborne navigational equipment that defines the instrument approach procedure and route to the alternate should be installed and operational. The Phase III published approach will include the underlying navaid and GPS in the title; however, the type of approach must be specifically requested and approved. For example, when electing to use GPS for the "VOR or GPS RWY 24" approach, the approach should be requested and approved as "GPS RWY 24". When electing to use the VOR for the approach, the approach should be requested and approved as "VOR RWY 24".

d. Additional criteria for all Phases. For all phases of the Approach Overlay Program, civil aircraft are not authorized to use GPS to fly any segment of any instrument approach under IFR weather conditions unless the following criteria are met:

(1) The GPS avionics used to fly any nonprecision instrument approach must be certified to TSO C129 or equivalent criteria. The installation in the aircraft should be in accordance with AC 20-138 and the provisions of the applicable Approved Flight Manual (AFM) or Flight Manual supplement should be met.

(2) The airborne navigation database should contain all waypoints for the published nonprecision approaches to be flown. The use of non-differential GPS equipment is not authorized for LOC, LDA, and SDF approaches.

(3) The approach cannot be flown unless that instrument approach is retrievable from the avionics database. Some approach procedures are not included in the database due to safety reasons or non-codability. It is the responsibility of the pilot to determine if the intended approach procedure is in the database.

(4) The GPS avionics should store all waypoints depicted in the approach to be flown, and present them in the same as the published nonprecision instrument approach procedure chart.

(5) Approaches must be flown in accordance with the FAA AFM or Flight Manual Supplement and the procedure depicted on the appropriate instrument approach chart.

(6) Any required alternate airport should have an approved instrument approach procedure, other than GPS or LORAN-C, which is anticipated to be operational at the estimated arrival time. The aircraft should have the appropriate avionics installed and operational to receive the navigational aids. The pilot is responsible for checking NOTAMs to determine the operational status of the alternate airport navigational aids.

(7) The general approval to use GPS to fly overlay instrument approaches is initially limited to the U.S. National Airspace System (NAS). GPS instrument approach operations outside the United States also should be authorized by the appropriate sovereign authority.

(8) Procedures should be established by the pilot in the event that GPS outages occur. In these situations, the pilot should rely on other approved equipment, delay departure, or discontinue IFR operations.

6. PILOT OPERATIONS.

a. Usually, flying a GPS overlay nonprecision instrument approach procedure is identical to a traditional approach. The differences include the navigational information displayed on the GPS equipment and the terminology used to describe some of the features. Flying the GPS stand alone approach is normally point to point navigation and independent of any ground based navaids. Appendix 1 contains sample charts with a brief explanation of how pilot operations are affected by the GPS approach operations. Appendix 2 contains a glossary with definitions to some of the unique terminology of GPS approaches.

(1) Straight line (TO-TO) flight from waypoint to waypoint, as sequenced in the database, does not assure compliance with the published approach procedure. Should differences between the approach chart and database arise, the published approach chart, supplemented by NOTAMs, holds precedence.

(2) Pilots should be aware that when flying a GPS overlay approach, a charted track defined by a VOR may differ slightly from the course to be flown as indicated by the GPS avionics. All magnetic tracks defined by a VOR radial are determined by the application of a VOR station variation; however, GPS operations use an algorithm to apply the current local magnetic variation. Therefore, a difference between the charted course and the GPS display may occur. Either method of navigation, VOR or GPS, should produce the same desired ground track.

b. Selecting the Approach.

(1) To begin the overlay or stand alone approach, the pilot must first select the appropriate airport, runway/approach procedure, and initial approach fix.

Note: The actual procedures, for making these selections, may vary from one avionics manufacturer to another; therefore, the pilot must be thoroughly familiar with the avionics manufacturer specifications.

(2) Pilots must arm (enable) approach mode prior to the IAF. This enables the equipment CDI sensitivity to increase from 5nm either side of centerline to 1 nm at the appropriate time. Where the IAF is beyond the 30 mile point, CDI sensitivity will not change until the aircraft reaches 30 miles. Where the IAF is at or inside the 30 mile point, CDI sensitivity change will occur at the time approach mode is armed. Should the pilot fail to arm approach mode prior to the IAF, the equipment will provide an aural and/or visual alarm to warn the pilot to do so. Should the pilot ignore the warning and fail to arm approach mode, the equipment will provide a 2nd and final warning at approximately 3nm from the FAF. If the pilot yet fails again to arm approach mode, the equipment will flag and GPS navigation guidance will not be provided beyond the FAF. The specific method by which the GPS equipment provides these warnings is up to the manufacturer, and is explained in the Flight Manual Supplement.

(3) The equipment will automatically present the waypoints from the initial approach fix to the missed approach holding point. An example of the selection process that a pilot should make and the automatic presentation of waypoints is shown in figure 2 which was taken from the Lake Charles, Louisiana overlay approach chart in Appendix 1. The example is for illustration purposes only.

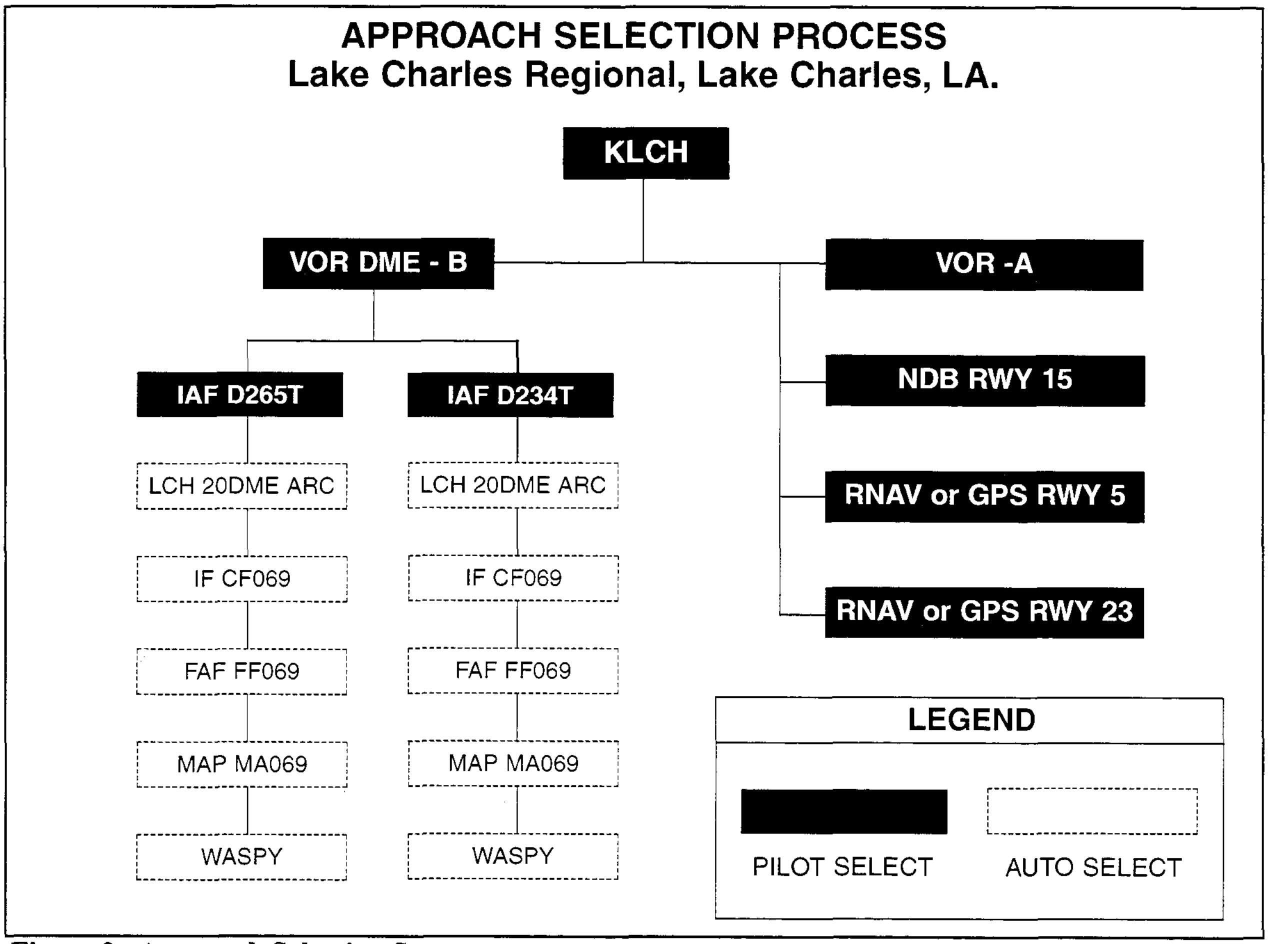


Figure 2. Approach Selection Sequence.

(4) At the MAP, the equipment will not automatically sequence to the next required waypoint; therefore, the pilot must manually sequence the GPS equipment to the next waypoint.

(5) With Radar Vectors (RV), the pilot may be required to manually select the next waypoint so that GPS is correctly using the appropriate database points and associated flight paths.

c. Initial Approach Segment. The following are some of the unique characteristics a pilot should be aware of during the initial approach segment of a nonprecision GPS approach.

(1) Arc Procedures. Arc procedures will only be encountered with overlay approaches. The method for navigating on arcs may vary with the manufacturer and pilots should use the procedures specified in the applicable AFM. It is not uncommon for an aircraft to be vectored onto the arc by ATC at a point other than the IAF for the arc. In these cases, the pilot should manually sequence the waypoints to the arc segment of the approach.

(2) Course Reversal Procedure. When performing a course reversal, such as a procedure turn or holding pattern in lieu of a procedure turn, the GPS equipment provides the capability for the pilot to change from the automatic waypoint sequencing to manual. The course reversal is flown using normal piloting techniques. The reversal and the return to automatic sequencing should be completed when established inbound on the final approach course to, but outside of the active waypoint.

Note: *The method or procedure used to switch the equipment from automatic sequencing to manual may vary between manufacturers. Pilots should use the procedure specified in the applicable AFM.*

(3) Turn Points in the Initial Segment. In some cases, a turn point is incorporated in the initial approach segment. ***Note:*** *It is important to recognize that the turn point may be either a named or coded waypoint.*

d. Intermediate Approach Segment. If an Intermediate Fix (IF) or waypoint is part of the instrument approach procedure, it is included in the database and is used the same as in a ground-based procedure.

e. Final Approach Segment. The following are some of the unique characteristics a pilot should be aware of during the final approach segment of a nonprecision GPS approach.

(1) Final Approach Fix (FAF) — Overlay Approach. In the Approach Overlay Program, the GPS equipment may display a FAF waypoint not depicted on the approach chart. Procedures without a FAF and without a stepdown fix have a sensor FAF waypoint coded in the database. This sensor FAF waypoint is at least 4nm to the MAP waypoint. In this case, the MAP waypoint is always located at the navaid facility. If a stepdown fix exists on the published procedure that is greater than 2nm to the MAP, the stepdown fix becomes the sensor FAF waypoint. If a stepdown fix is 2nm or less to the MAP, a sensor FAF waypoint is established 4nm to the MAP. The sensor FAF is necessary to transition the display sensitivity on the GPS equipment from terminal to approach sensitivity. During communications with ATC, the pilot should make position reports based on charted positions, not the display on the GPS equipment, since the controller does not have access to this information. Examples of these situations are shown in the sample charts in Appendix 1.

(2) Final Approach Waypoint — GPS Stand Alone Approach. The final approach waypoint for a GPS stand alone approach will be a standard named waypoint normally located five nautical miles from the runway end.

(3) Course Sensitivity. The Course Deviation Indicator (CDI) sensitivity related to GPS equipment varies with the mode of operation. In the en route phase, prior to the execution of the instrument approach, the display sensitivity full scale deflection is 5nm either side of centerline.

(i) Upon activation of the approach mode, the display sensitivity transitions from a full scale deflection of 5nm to 1nm either side of centerline.

(ii) At a distance of 2nm inbound to the FAF waypoint, the display sensitivity begins to transition to a full scale deflection of 0.3 nautical miles either side of centerline. Some GPS avionics may provide an angular display between the FAF and MAP that approximates the course sensitivity of the localizer portion of an ILS.

(iii) When navigation to the missed approach holding point is activated, the display sensitivity transitions to provide a full scale deflection of one nautical mile either side of centerline.

(4) Stepdown Fixes. A stepdown fix is flown in the same manner as a ground-based approach. Stepdown fixes on overlay approaches will not be identified with a waypoint unless it is named by the FAA. An unnamed stedown fix will not appear in the database sequence of waypoints. Pilots should be aware that the distance readout in the GPS display equates to the *distance-to-go to the active waypoint*. If the stepdown fix has not been assigned a waypoint name in the database (for overlay approach stepdown fixes), the distance-to-go readout may not correspond to the DME distance of the stepdown fix shown on the published approach chart. The pilot should monitor the along track distance (ATD) to the MAP to identify the stepdown fix. For stand alone GPS procedures, any required stepdown fixes prior to the missed approach waypoint will be identified by along track distances.

Note: *An approach fix identified by a DME will not be displayed on the GPS receiver unless there is a published name assigned to the DME fix. If the fix is not assigned a waypoint name, the distance-to-go (ATD) displayed on the GPS receiver may not agree with the approach chart DME reference distance.*

f. Missed Approach Segment. The following are some of the unique characteristics a pilot should be aware of during the missed approach segment of a nonprecision GPS approach.

(1) Missed Approach Point (MAP). The MAP waypoint on an overlay approach may be located at the runway threshold, the underlying facility, or at a specified distance from the runway or facility. There may be a difference between the along track countdown to the waypoint in the GPS equipment and the DME distance from a facility shown on the chart. Pilots need to take into account any differences when interpreting the distance shown in the GPS display against the charted values.

(2) Manual Activation of Missed Approach Function. After passing the missed approach point, the GPS equipment will not automatically sequence to the missed approach holding waypoint. When initiating a missed approach the pilot, upon passing the MAP, should manually sequence the GPS equipment to the next active waypoint. This may not necessarily be a missed approach holding waypoint, but may be a turn waypoint en route to the missed approach holding waypoint. The missed approach should be flown as charted using the same piloting techniques as a traditional missed approach.

William J. White
Deputy Director, Flight Standards Service

APPENDIX 1 — SAMPLE CHARTS

ROANOKE RAPIDS, NORTH CAROLINA, NDB or GPS RUNWAY 5
(Halifax County Airport)

After selecting the airport and approach information as outlined in the FAA Approved Flight Manual or Flight Manual Supplement, the waypoints will be automatically presented in the proper order to fly the approach. Pilots must arm (enable) approach mode prior to the IAF. This approach is considered a Phase III GPS Approach Overlay since "or GPS" appears in the title. The feeder routes from the Lawrenceville VORTAC, GUMBE Intersection, Tar River VORTAC, and DUFFI Intersection are outside the IAF. These routes are not required in the approach procedure sequence of waypoints. ***Note:*** *Some manufacturers may include feeder route information.*

Notice that this approach does not have an FAF. For the final sensitivity reduction to take place however (a requirement for a GPS overlay approach), an FAF waypoint must be established. For this approach, the database and GPS display includes a "sensor FAF," which is located at the default distance of 4nm to the MAP for Runway 05. It is identified in the database as FF05 (Final Approach Fix for Runway 05), but may not appear on the approach chart.

At the IAF (RZZ), the GPS equipment automatically sequences to the next waypoint, in this case the sensor FAF (FF05). After passing the IAF and prior to reaching the sensor FAF, the receiver is put on hold either by the pilot or automatically by the equipment depending on the manufacturer. TO-FROM navigation and an along track distance are provided in relation to the active waypoint, which in this case, is still the FAF. The procedure turn should be completed beyond the sensor FAF to ensure that the waypoint sequencing is properly achieved and that the receiver sensitivity is correctly activated. The procedure turn also should be completed within the protected airspace for the approach. In this case, withn 10nm from RAPIDS.

On the outbound leg of the procedure turn, set the final approach course (058°) on the OBS. When the inbound course is intercepted, the receiver is returned to automatic sequencing either by the pilot or automatically by the equipment depending on the manufacturer. TO-TO navigation and an along track distance are provided to the sensor FAF (FF05). At 2nm from the sensor FAF, the display sensitivity begins to transition to .3nm either side of centerline. At the sensor FAF, the GPS equipment automatically sequences to the MAP waypoint (RZZ) with an along track distance provided to the MAP.

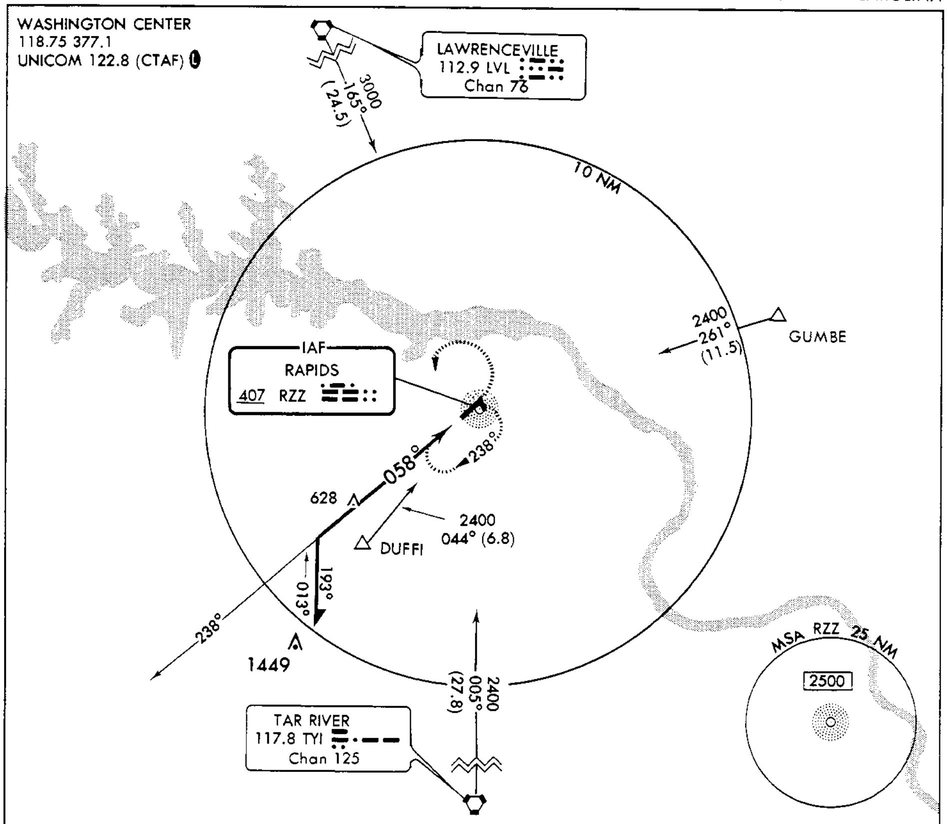
At the MAP, the GPS equipment must be manually sequenced to the next active waypoint. Once selected, the navigation equipment will display the missed approach holding point (RZZ). Display sensitivity full scale deflection changes to one nautical mile. The missed approach procedure is flown as depicted on the chart using normal piloting techniques; in this case, a climbing left turn to 2,400 feet and entry into a holding pattern at the RZZ waypoint. DIRECT-TO navigation is used to RZZ. After passing RZZ and while entering missed approach holding, the receiver is put on "hold" for the missed approach holding pattern.

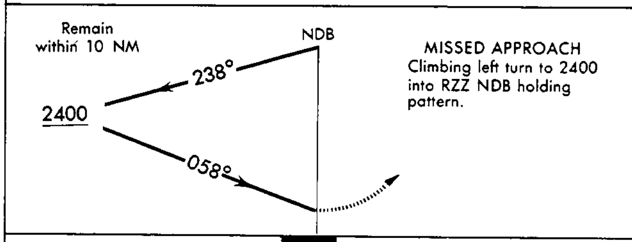
Amdt 3 94118

NDB or GPS RWY 5

AL-6379 (FAA)

ROANOKE RAPIDS/HALIFAX COUNTY (RZZ)
ROANOKE RAPIDS, NORTH CAROLINA



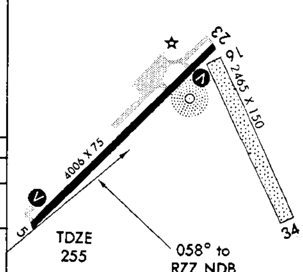


MISSED APPROACH
Climbing left turn to 2400 into RZZ NDB holding pattern.

CATEGORY	A	B	C	D
S-5	980-1 725 (800-1)		980-2 725 (800-2)	980-2¼ 725 (800-2¼)
CIRCLING	980-1 725 (800-1)		980-2 725 (800-2)	980-2¼ 725 (800-2¼)

Obtain local altimeter setting on CTAF; When not available use Rocky Mount altimeter setting and increase all MDAs 160 feet. When Rocky Mount altimeter setting not available, procedure not authorized.
△ NA

ELEV 256



MIRL Rwy 5-23
REIL Rwys 5 and 23

Knots	60	90	120	150	180
Min:Sec					

NDB or GPS RWY 5

36°26'N – 77°43'W

ROANOKE RAPIDS, NORTH CAROLINA
ROANOKE RAPIDS/HALIFAX COUNTY (RZZ)

PROVIDENCE, RHODE ISLAND, VOR RUNWAY 5
(Green State Airport)

After selecting the airport and approach information as outlined in the FAA Approved Flight Manual or Flight Manual Supplement, the waypoints will be automatically presented in the proper order to fly the approach. Pilots must arm (enable) approach mode prior to the IAF. Since the words "or GPS" are not included in the title of the published approach procedure chart, it may be considered a Phase II GPS Overlay Approach procedure. This chart includes the database identifiers and waypoints for the GPS Overlay Approach.

This approach can be initiated from one of two Initial Approach Fix waypoints: LAFAY or RENCH. The waypoint sequence if the approach is started from LAFAY is LAFAY (IAF), the turn point in the initial segment (identified by the database code PVD17), RENCH (FAF), Providence VOR (MAP), and FOSTY (MAHP). The first portion of the route is flown to a turn point waypoint. Course guidance and an along track distance is provided to the turn waypoint (PVD17) to intercept the 045° inbound course to RENCH. After passing PVD17 and intercepting the inbound course, the along track distance to RENCH can be used to determine the distance remaining to the FAF.

If the approach is initiated from over RENCH, the waypoint sequence is RENCH (IAF/FAF), Providence VOR (MAP), and FOSTY (MAHP). The LOM serves as the IAF and the FAF. Prior to passing RENCH IAF outbound, the GPS receiver is put on hold to fly the course reversal. Depending on the manufacturer, this may be a pilot action or done automatically by the equipment. The course reversal is flown as charted with TO-FROM navigation provided in relation to the active waypoint, which in this case, is RENCH FAF. Once established on the inbound course, the receiver should be returned to automatic waypoint sequencing (TO-TO navigation). Depending on the manufacturer, this may be a pilot action or done automatically by the equipment. An along track distance is provided to RENCH FAF. At 2nm from RENCH FAF, the display sensitivity transitions to where full scale deflection is 0.3nm either side of centerline.

At the FAF, the waypoint automatically sequences to the MAP. An along track distance is provided to the MAP waypoint (PVD). Since the stepdown fix (D2.5) is not an FAA named fix, it is not included in the waypoint presentation; however, the point can be identified by an along track distance to PVD. When the ATD is 2.5nm to the MAP, the fix is identified. Note that on some approaches this distance may be different from the DME distance depicted in the profile view. In such cases, the along track distance at the bottom of the profile view can be used to monitor the distance readout.

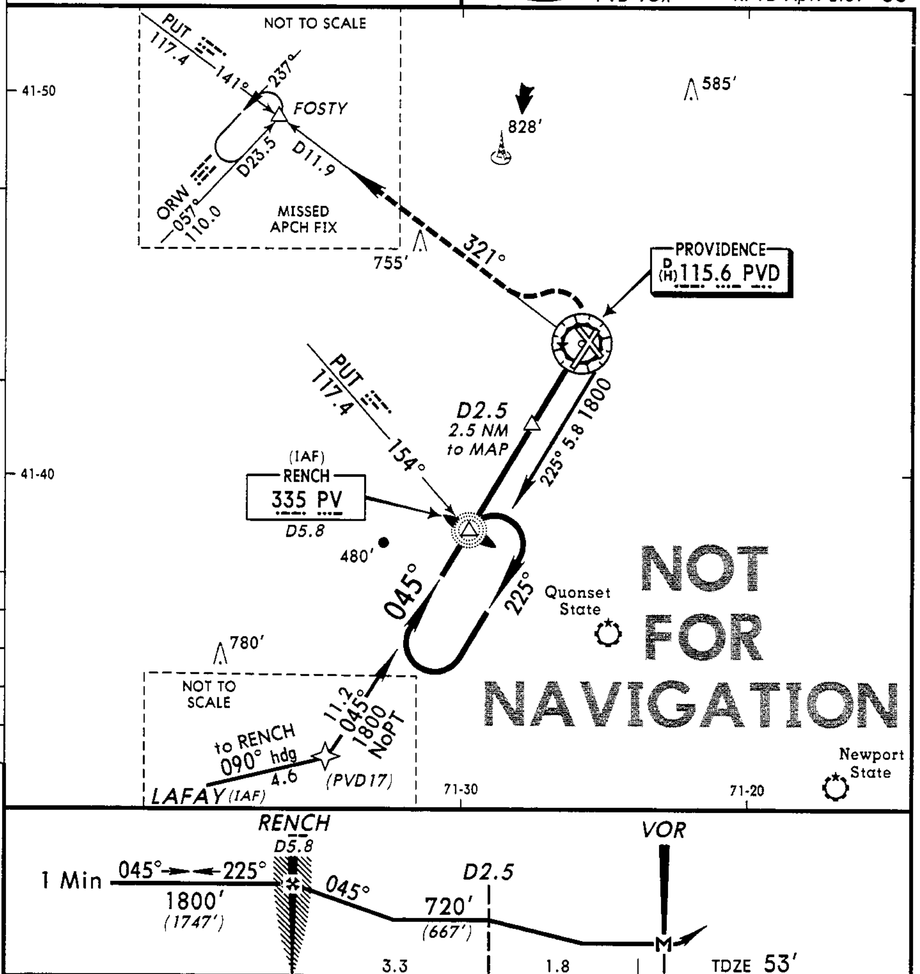
At the MAP waypoint, the receiver automatically changes to manual operation and the pilot must manually sequence to the next active waypoint. Once complete, display sensitivity changes to full scale deflection of one nautical mile, and the missed approach holding point is displayed as the next waypoint. The first part of the missed approach procedure is flown as depicted on the chart: climbing left turn to 2,500 feet. Normal piloting techniques are used to intercept a 321° course (a TO-TO bearing of 321°) to FOSTY.

JEPPESEN 15 JUL 94 (13-2) Eff 21 Jul

PROVIDENCE, RI
GREEN STATE
VOR Rwy 5
(GPS) VOR 115.6 PVD
KPVD Apt. Elev 55'

ATIS 124.2
*PROVIDENCE Approach (R) 135.4
BOSTON Center 124.85 when App inop.
*PROVIDENCE Tower CTAF 120.7
*Ground 121.9

MSA PVD VOR 2200'



MISSED APPROACH: Climbing LEFT turn to 2500' outbound via PVD VOR R-321 to FOSTY INT and hold.

	STRAIGHT-IN LANDING RWY 5: MDA(H) 540'(487') With D2.5	ALS out	MDA(H) 720'(667') Without D2.5	ALS out	Max Kts	CIRCLE-TO-LAND With D2.5 MDA(H)	CIRCLE-TO-LAND Without D2.5 MDA(H)
A	RVR 24 or 1/2	RVR 50 or 1	RVR 24 or 1/2	RVR 50 or 1	90	560'(505')-1	720'(665')-1
B					120		
C	RVR 40 or 3/4	RVR 60 or 1 1/4	RVR 60 or 1 1/4	1 3/4	140	580'(525')-1 1/2	720'(665')-1 3/4
D	RVR 50 or 1	1 1/2	1 1/2	2	165	620'(565')-2	720'(665')-2

AMEND 12 MAP at VOR

CHANGES: Procedure.

LAKE CHARLES, LOUISIANA, VOR DME-B
(Lake Charles Regional Airport)

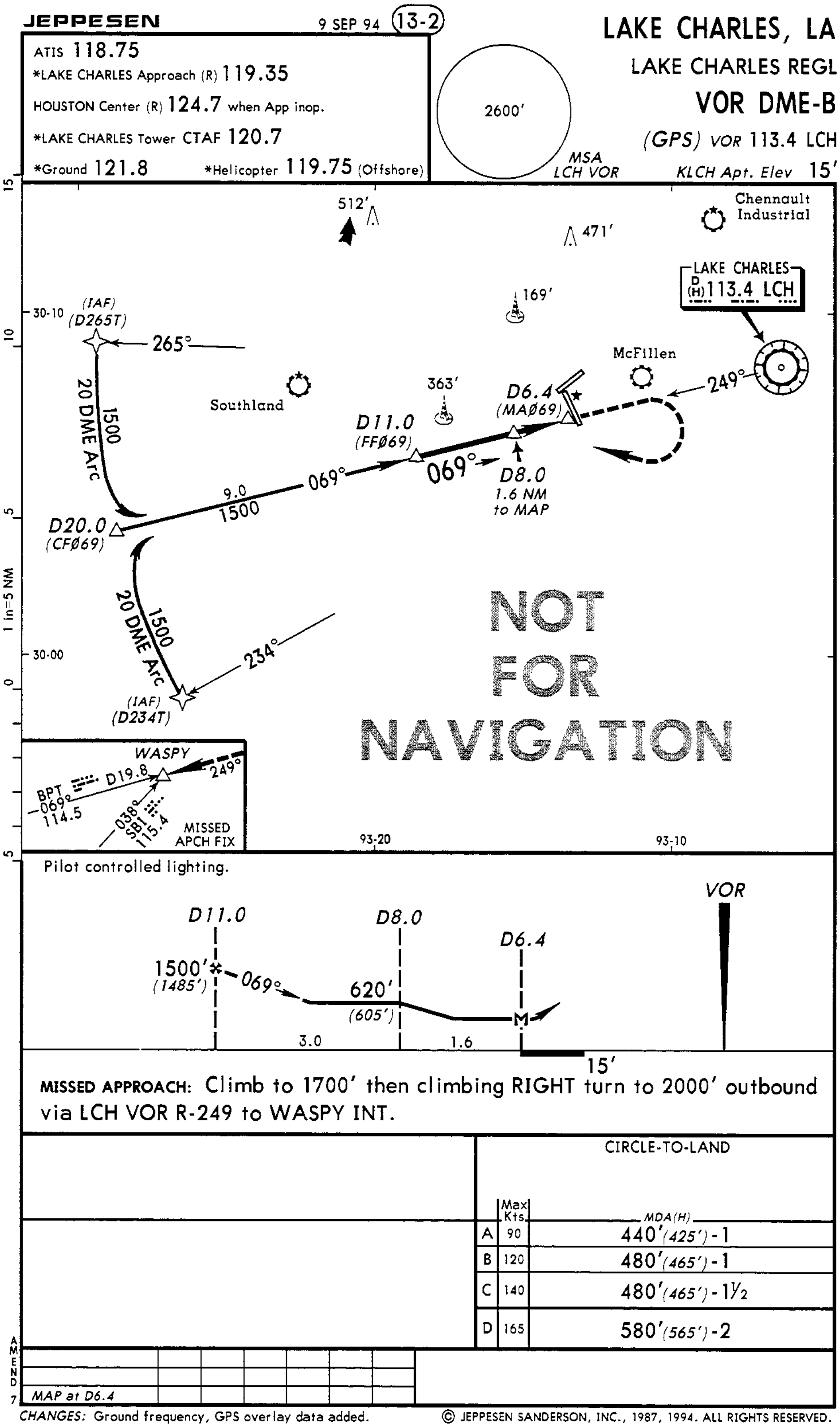
After selecting the airport and approach information as outlined in the FAA Approved Flight Manual or Flight Manual Supplement, the waypoints will be automatically presented in the proper order to fly the approach. Pilots must arm (enable) approach mode prior to the IAF. This example represents a Phase II GPS Overlay Approach.

This approach can be initiated from one of two Initial Approach Fix waypoints. These IAF waypoints are along the 20nm arc at points defined by the 234 and 265 degree radials from LCH. The IAF at R-234 will likely appear in the database as D234T. D234T represents a point located on the 234 degree radial of the Lake Charles VORTAC at 20nm. The letter T is the twentieth letter of the alphabet and is used to indicate a distance of 20nm. In addition, a waypoint is coded in the database at the intersection of the arc and final approach course (CF069). The approach waypoint sequence in this case is D234T (IAF), CF069, FF069 (FAF), MA069 (MAP), WASPY. The same sequence is provided for the other arc, except that it starts at D265T. The display in the receiver and procedure for flying the arc may vary with the manufacturer. Pilots should consult the FAA Approved Flight Manual, or Flight Manual Supplement for further details.

From either IAF normal piloting techniques are used to maintain the ground track of the arc enroute to the waypoint located at the intersection of the arc and the final approach course (CF069). From here the GPS equipment will sequence to the FAF (FF069). At 2nm from the FAF, the display sensitivity begins transitioning to where full scale deflection is .3nm either side of centerline.

At the FAF, the waypoint automatically sequences to the MAP (MA069). An along track distance is provided to the MAP wayoint. Since the stepdown fix (D8.0) is not an FAA named fix, it is not included in the waypoint presentation; however, the point can be identified by an along track distance to MA069. When the ATD is 1.6nm to the the MAP, the fix is identified. Note that on this approach there is a difference between the DME distance depicted in the profile view and the along track distance. In such cases, the along track distance at the bottom of the profile view can be used to monitor the GPS distance readout.

At the MAP waypoint, the receiver automatically changes to manual operation and the pilot must sequence the receiver to the next active waypoint. Once complete, the missed approach waypoint (WASPY) is displayed as the next wayoint. The first part of the missed approach procedure is flown as depicted on the chart: Climb to 1,700 feet, then climbing right turn to 2,000 feet outbound via LCH VOR R-249 to WASPY. Normal piloting techniques are used to intercept a 249° course (a TO-TO bearing of 249°) to WASPY. Display sensitivity begins to change to a full scale deflection of one nautical mile either side of centerline once WASPY is sequenced.


JEPPESEN
9 SEP 94 (13-2)
LAKE CHARLES, LA
LAKE CHARLES REGL
VOR DME-B
(GPS) VOR 113.4 LCH
KLCH Apt. Elev 15'
ATIS 118.75
*LAKE CHARLES Approach (R) 119.35
HOUSTON Center (R) 124.7 when App inop.
*LAKE CHARLES Tower CTAF 120.7
*Ground 121.8 *Helicopter 119.75 (Offshore)
2600'
MSA LCH VOR
Chennault Industrial
LAKE CHARLES D (H) 113.4 LCH
(IAF) (D265T)
265°
20 DME Arc 1500
Southland
McFillen
D11.0 (FF069)
D6.4 (MA069)
D8.0 1.6 NM to MAP
069°
249°
D20.0 (CF069)
9.0 1500
(IAF) (D234T)
234°
WASPY
BPT 069° 114.5
D19.8
038° SBI 115.4
MISSED APCH FIX
NOT FOR NAVIGATION
Pilot controlled lighting.
1500' (1485')
620' (605')
3.0
1.6
VOR
15'
MISSED APPROACH: Climb to 1700' then climbing RIGHT turn to 2000' outbound via LCH VOR R-249 to WASPY INT.
CIRCLE-TO-LAND
Max Kts MDA(H)
A 90 440'(425')-1
B 120 480'(465')-1
C 140 480'(465')-1½
D 165 580'(565')-2
MAP at D6.4
CHANGES: Ground frequency, GPS overlay data added.
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OSHKOSH, WISCONSIN, GPS RUNWAY 27
(Wittman Regional Airport)

After selecting the airport and approach information as outlined in the FAA Approved Flight Manual or Flight Manual Supplement, the waypoints will be automatically presented in the proper order to fly the approach. Pilots must arm (enable) approach mode prior to the IAF. This stand alone GPS approach can be initiated from one of four Initial Approach Fix waypoints: PEENA, FLOUN, AMAZE, or the Falls VOR.

If the approach is started from either FLOUN, AMAZE, or the Falls VOR, the waypoint sequence would be the appropriate IAF, PRIMO, PEENA (FAF), HNSON (MAP), and GRATE (MAHP). After passing the appropriate IAF, course guidance (TO-TO navigation) and an along track distance is provided to the IF waypoint (PRIMO). Once the inbound course is intercepted, the along track distance to PEENA can be used to determine the distance remaining to the FAF.

If the approach is initiated from over PEENA, the waypoint sequence is PEENA (IAF/FAF), HNSON (MAP), and GRATE (MAHP). PEENA serves as the IAF and FAF. Prior to passing PEENA (IAF) outbound, the GPS receiver is put on hold to fly the course reversal. Depending on the manufacturer, this may be a pilot action or done automatically by the equipment. The course reversal is flown as charted with TO-FROM navigation provided in relation to the active waypoint, which in this case, is PEENA FAF. Once established on the inbound course, the receiver must be returned to automatic waypoint sequencing (TO-TO navigation). Depending on the manufacturer, this may be a pilot action or done automatically by the equipment. An along track distance is provided to PEENA FAF.

At 2nm from PEENA FAF, the display sensitivity begins transitioning to where full scale deflection is .3nm either side of centerline. At the FAF the waypoint automatically sequences to the MAP (HNSON) and the along track distance will show the distance remaining to the MAP.

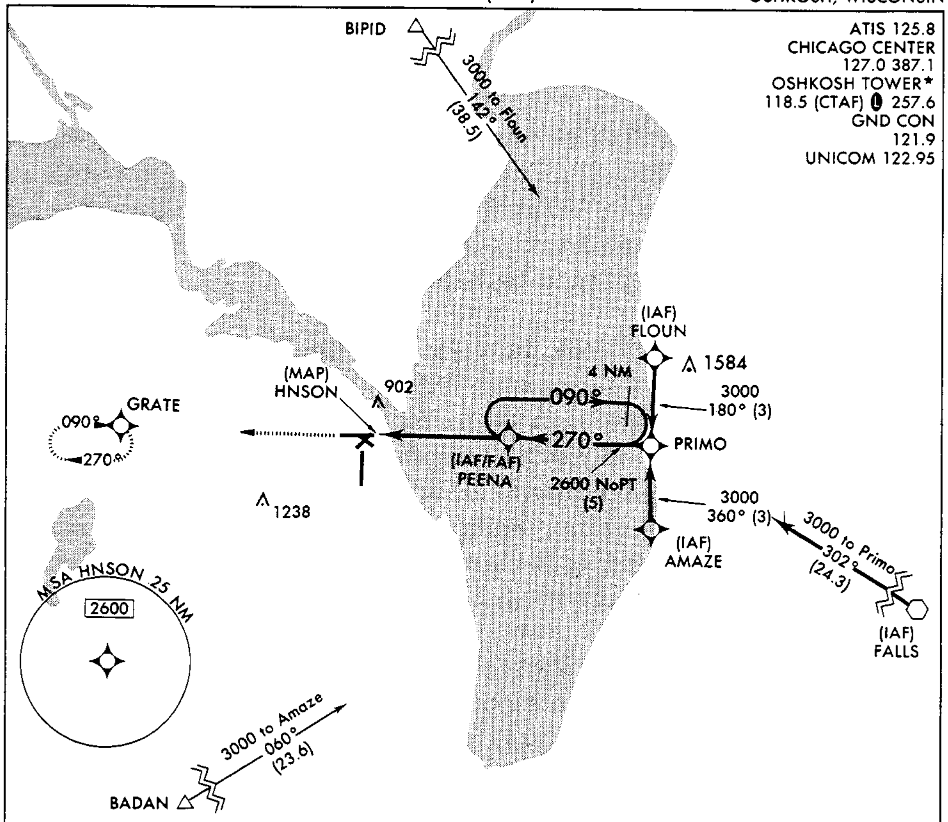
At HNSON the receiver automatically changes to manual operation and the pilot should manually sequence to the next active waypoint. Once complete, the missed approach holding point (GRATE) is displayed. Normal piloting techniques are used to climb to 3,000 feet and intercept a 271° course (a TO-TO bearing of 271°) to GRATE. Upon sequencing to GRATE the display sensitivity begins to change to a full scale deflection of one nautical mile.

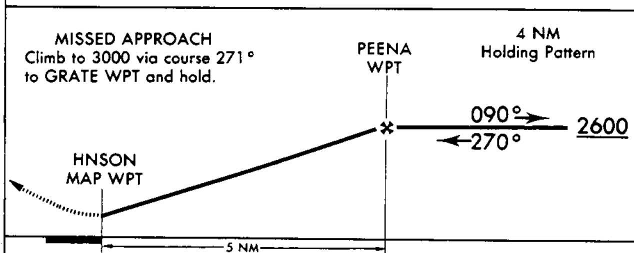
Orig 94286

GPS RWY 27

AL-730 (FAA)

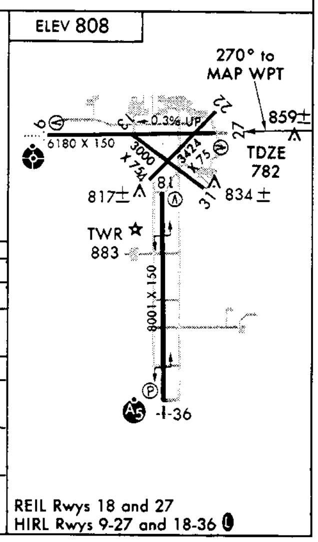
OSHKOSH/WITTMAN REGIONAL (OSH)
OSHKOSH, WISCONSIN





CATEGORY	A	B	C	D
S-27	1120-1 338 (400-1)			
CIRCLING	1260-1 452 (500-1)		1260-1½ 452 (500-1½)	1360-2 552 (600-2)
GREEN BAY ALTIMETER SETTING MINIMUMS				
S-27	1220-1 438 (500-1)		1220-1¼ 438 (500-1¼)	1220-1½ 438 (500-1½)
CIRCLING	1360-1 552 (600-1)		1360-1½ 552 (600-1½)	1480-2¼ 672 (700-2¼)

When control tower closed, except for operators with approved weather reporting service, use Green Bay altimeter setting.
△ NA



GPS RWY 27
Orig 94286

43°59'N-88°33'W

OSKOSH, WISCONSIN
OSHKOSH/WITTMAN REGIONAL (OSH)

APPENDIX 2 — GLOSSARY

Active Waypoint — The waypoint to/from which the navigational guidance is being provided.

Along Track Distance (ATD) Fix — A distance in nautical miles (NM) to the active waypoint along the specified track. An ATD fix will not be used where a course change is made.

Course Set — Guidance set from information provided by the GPS equipment that assists the pilot in navigating to or from an active waypoint on a heading/bearing.

Data Agency — An agency, public or private, other than a publisher of government source documents, who compiles official document information into charts or electronic formats for cockpit use.

Dead Reckoning (DR) — The navigation of an airplane solely by means of computations based on airspeed, course, heading, wind direction and speed, ground speed, and elapsed time.

Direct To — A method used with the GPS equipment to provide the necessary course from present position directly to a selected waypoint. This is not the *course* waypoint to waypoint.

En Route Domestic — The phase of flight between departure and arrival terminal phases, with departure and arrival points within the U.S. National Airspace System (NAS).

En Route Oceanic — The phase of flight between the departure and arrival terminal phases, with an extended flight route over the high seas.

En Route Operations — The phase of navigation covering operations between departure and arrival terminal phases. The en route phase of navigation has two subcategories: en route domestic and en route oceanic.

Fly By Waypoint — An waypoint that permits turn anticipation and does not require the aircraft to pass directly over it.

Fly Over Waypoint — A waypoint that requires the aircraft to pass directly over it.

Geodetic Datum — The numerical or geometrical quantity or set of such quantities (mathematical model) which serves as a reference for computing other quantities in a specific geographic region such as the latitude and longitude of a point.

Global Navigation Satellite Systems (GNSS) — An "umbrella" term adopted by the International Civil Aviation Organization (ICAO) to encompass any independent satellite navigation system used by a pilot to perform onboard position determinations from the satellite data.

Global Positioning System (GPS) — A U.S. space-based positioning, velocity, and time system composed of space, control, and user elements. The space element, when fully operational, will be composed of 24 satellites in six orbital planes. The control element consists of five monitor stations, three ground antennas and a master control station. The user element consists of antennas and receiver-processors that provide positioning, velocity, and precise timing to the user.

Instrument Approach Waypoints — Geographical positions, specified in latitude/longitude used in defining GPS instrument approach procedures, including the initial approach waypoint, the intermediate waypoint, the final approach waypoint, the missed approach waypoint, and the missed approach holding waypoint.

Integrity — The probability that the system will provide accurate navigation as specified, or timely warnings to users when GPS data should not be used for navigation.

National Airspace System (NAS) — The common network of U.S. airspace; air navigation facilities, equipment and services, airport or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

Nonprecision Approach Operations — Those flight phases conducted on charted Standard Instrument Approach Procedures (SIAPs) commencing at the initial approach fix and concluding at the missed approach point or the missed approach holding point, as appropriate.

Oceanic Airspace — Airspace over the oceans of the world, considered international airspace, where oceanic separation and procedures per the International Civil Aviation Organization (ICAO) are applied. Responsibility for the provisions of air traffic control service in this airspace is delegated to various countries, based generally upon geographic proximity and the availability of the required resources.

Pseudo-Range — The determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves. The distance from the user to a satellite plus an unknown user clock offset distance. With four satellite signals it is possible to compute position and clock offset distance.

Receiver Autonomous Integrity Monitoring (RAIM) — A technique whereby a civil GPS receiver/processor determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function.

Secondary Sensor — Any input from other aircraft systems that may be used to derive navigation information.

Selective Availability (SA) — A method by which the Dept. of Defense can artificially create a significant time and positioning error in the satellites. This feature is designed to deny an enemy the use of precise GPS positioning data.

Sensor FAF — A final approach waypoint created and added to the database sequence of waypoints to support GPS navigation of an FAA published, no-FAF, nonprecision instrument approach procedure.

Supplemental Air Navigation System — An approved navigation system that can be used in conjunction with, or in addition to, a primary air navigation system. May be used as the sole navigation system provided an operational approved alternate (primary) navigation system, suitable for the route of flight, is installed on the aircraft.

Terminal Area Operations — Those flight phases conducted on charted Standard Instrument Departures (SIDs), on Standard Terminal Arrival Routes (STARs), or other flight operations between the last en route fix/waypoint and the initial approach fix/waypoint.

TO-FROM Navigation — RNAV equipment in which the desired path over the ground is defined as a specific (input quantity) course emanating either to or from a particular waypoint. The equipment functions like a conventional VOR receiver where the CDI needle and the "to/from" indicator responds to movement of the OBS. In this equipment, the aircraft may fly either TO or FROM any single designated waypoint.

TO-TO Navigation — RNAV equipment in which a path is computed that connects two waypoints. In this equipment, two waypoints must always be available, and the aircraft is usually flying between the two waypoints and TO the active waypoint. In this equipment the CDI needle functions like its tracking a localizer signal; that is movement of the OBS has no effect on the CDI needle or the "to/from" indicator.

Turn Anticipation — The capability of RNAV systems to determine the point along a course, prior to a turn waypoint, where a turn should be initiated to provide a smooth path to intercept the succeeding course within the protected airspace, and to enunciate the information to the pilot.

User-selectable Navigation Database — A navigation database having user-defined contents accessible by the pilot and/or the navigation computer during aircraft operations in support of navigation needs. This database is stored electronically and is typically updated at regular intervals, such as the AIRAC 28-day cycle. It does not include data that can be entered manually by the pilot or operator.

Waypoint (WP) — A predetermined geographical position used for route definition and/or progress reporting purposes that is defined by latitude/longitude.

World Geodetic System (WGS) — A consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the center of mass of the earth, transformations from major geodetic datums, and the potential of the earth (usually in terms of harmonic coefficients).

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